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# Flexibility Fuels Cable Assembly Design For Satellite Electronics

Harrisburg, PA — January xx, 2004 — When designing electronic components and sub-assemblies for use in space vehicles and satellites, engineers from Tyco Electronics main concerns often deal with weight, performance and reliability. These design concerns were front and center when Tyco Engineers were working on a project for Northrop Grumman Corporation, the prime contractor for the National Polar-orbiting Operational Environmental Satellite System (NPOESS). Another design concern emerged, however; flexibility.

NPOESS is a system used to monitor global environmental conditions. In 1994, government agencies such as the Department of Commerce (DoC) and the Department of Defense (DoD) identified that some of their low earth orbit observation needs were converging. So, in an attempt to improve the efficiency of both agencies, a convergence plan was submitted to the U.S. Congress. Long story short, the plan was approved and a presidential directive emerged. The NPOESS system will provide numerous earthly entities with atmospheric, oceanographic, terrestrial and solarphysical data that help improve long-term environmental monitoring and short-term weather forecasting.

**Back to Designing Electronic Components for Satellites**

As engineers from Tyco Electronics were engaged with a potential interconnect project with Northrop Grumman, design flexibility was a major concern as it is in most major military and aerospace programs. After all, Tyco Electronics had considerable experience in new mil-aero platforms and those experiences confirmed that design requirements might change dramatically from the initial request for proposal (RFP) to the final design.

So, when Tyco Electronics was approached about a way to standardize electrical interconnects between systems and subsystems aboard NPOESS, Tyco's engineers considered the application, the products suitable for the application, and how to integrate the products into Northrop Grumman's satellite design. Later on, Tyco Electronics was issued a design specification for the electrical interconnects.

The design requirements were fairly straightforward at the start. Tyco Electronics needed to supply Northrop Grumman an IEEE 1394 compatible connector, also known as a Firewire compatible connector. Firewire connectors and cable assemblies are used in many consumer electronic applications like digital video cameras and other consumer devices that may connect a portable device to a PC. The main difference in the specifications Tyco Electronics had to meet, though, was that the connectors for Northrop Grumman, needed to meet specific electrical performance requirements and be suitable for space use.

As the connector system project progressed, Tyco Electronics was informed that Northrop Grumman was not only looking for connectors, but also complete cable assemblies to connect the subsystems and instruments to the main computer on the satellite. Tyco Electronics was able to

respond to this new request with a design from Tyco Electronics' MICRODOT micro miniature connector team.

Micro miniature connectors have contacts at very close spacing between contacts with .050" centerlines being standard. Tyco's proposed design originated from proposals made to Northrop Grumman for similar connector products some 18 months earlier. In the earlier proposals, Tyco showed Northrop Grumman the design for the MQR connector family. The MQR is a standard product for Tyco and had gained a good reputation in the aerospace and defense industry due to its reliability and convenient push-pull mating mechanism. The original design of the MQR was a seven contact position version with signal grade contacts.

Northrop Grumman's specs called for only six contact positions.

In order to meet Northrop Grumman's requirements, Tyco Electronics engineered the cable assembly with two 22 AWG contacts for power and two twisted shielded pair signal lines for a total of four 24 AWG signal contacts. Tyco engineers believed they could package the six contacts into the housing without much trouble, so they quickly drew up a connector with the six contact configuration. Tyco Electronics received encouraging feedback from Northrop Grumman's initial design review of the cable assembly. Some changes in the original connectivity concept, however, required Tyco to change the mating mechanism for the connector from push-pull design to a threaded design. The contact configuration, however, was acceptable. So, Tyco engineers looked at the considerable portfolio of housings for MICRODOT connectors and since the MQR connector design was fairly flexible, were able to integrate a threaded housing very quickly, saving the program considerable design delay.

The second connector design review yielded favorable results for Tyco Electronics. Northrop Grumman was ready to proceed with the proposed threaded mating design and contact configuration. Since the project developed from a discrete component project (connectors) to a complete cable assembly, Tyco Electronics was able to simplify Northrop Grumman's supply chain.

Following the decision to design a complete cable assembly, Tyco Engineers now had to make the entire assembly "space friendly". To accomplish the space proofing of the assembly, it was important to address electromagnetic interference (EMI) requirements as well as consider out-gassing of materials. Lastly, Tyco's team had to consider reliability and ruggedness issues for space-bound products as well as make the cable assembly easily scalable into various lengths for use in different locations on the satellite.

In addressing the EMI requirements, Tyco Electronics engineers applied some basic design principles. First of all, they selected nickel-plated aluminum for the connector housing since it helps mitigate EMI, withstands high frequency vibrations, and is lightweight. Tyco engineers also kept a keen eye on out-gassing, as they selected materials for the insulators and bonding materials. In addition to selecting the proper housing material, engineers also explored ways to thoroughly ground the assembly. To accomplish adequate grounding, they designed the cable/connector interface so that the cable braid was grounded 360° throughout the system. Other proprietary EMI mitigation methods were used as well.

To address out-gassing performance, Tyco Electronics engineers selected liquid crystal polymer (LCP) for the plastic components on the connector. The cable insulation and potting compound were low-out-gassing material as well. A systematic approach in reviewing all components helped simplify the polymer selection process.

A final detail of the project was for Tyco Electronics to design a board-mount header to accept the other end of the cable assembly. To keep the design simple, a “ganged” header was proposed. With this design, six individual mating headers were combined into one assembly that would mount onto a printed circuit board. A series of ground pins secure the header manifold onto the board via solder attachment, creating excellent electrical and mechanical bonds between the board and the header. From there, the board and header manifold are screw attached to a bulkhead, also creating an excellent electrical bond.

With the last touches on grounding, out-gassing and cable termination complete, Tyco Electronics was ready to deliver the first article product for evaluation and testing on what ended up being a new connector interface designed that was, developed, and delivered in only 4 months. The first cable assemblies met Northrop Grumman’s requirements and production soon ramped up. Although the NPOESS program actually reduces the number of polar-orbiting satellite groups from four to three, a significant number of the cable assemblies are used on each satellite. Despite the cable assemblies being only a small part of a highly sophisticated system, the teamwork and communication between Tyco Electronics and Northrop Grumman’s engineering teams personify some of the necessary ingredients that contribute to overall program success.

A little design flexibility helped too!

**ABOUT TYCO ELECTRONICS**

Tyco Electronics, a major business segment of Tyco International Ltd., is the world’s largest passive electronic components manufacturer; a world leader in cutting-edge wireless, active fiber optic and complete power systems technologies; and is also rapidly developing extensive networking and building technology installation services. Tyco Electronics provides advanced technology products from over forty

well-known and respected brands, including Agastat, Alcoswitch, AMP, AMP NETCONNECT, Buchanan, CII, CoEv, Critchley, Elcon, Elo TouchSystems, M/A-COM, Madison Cable, Microdot, OEG, OneSource Building Technologies, Potter & Brumfield, Precision Interconnect, Raychem, Schrack, Simel and TDI Batteries.